Active Project (2015 - 2017)

Fabrication and Testing of Nuclear-Thermal Propulsion Ground Test Hardware, Phase II Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

ABSTRACT

Efficient nuclear-thermal propulsion (NTP) requires heating a low molecular weight gas, typically hydrogen, to high temperature and expelling it through a nozzle. The higher the temperature and pressure, the higher the thrust and specific impulse. For ground test facilities that will be heating the gas to temperatures up to 4400F (2425C), the number of materials that can be used is severely limited. The need for compatibility with hot hydrogen limits the field even further. In Phase I, Ultramet designed, fabricated, and tested a system for heating high-pressure hydrogen to temperatures approaching 2400C. The system included a foam-based heating element, an insulation package, and a carefully designed multiwalled pressure vessel that could contain the hot gas at pressures up to 2000 psig. The Phase I effort demonstrated the suitability of the selected materials and the overall design approach. Phase II will focus on scaling up the system, fabricating and testing hardware, and laying out a clear path to a system that can deliver hot hydrogen at flow rates up to 40 lbm/sec (the highest flow rate currently of interest to NASA) at pressures up to 2000 psig. The overall system will be composed of multiple modules, and each module will be comprised of multiple heating elements. Because the design is modular, flows higher than 40 lbm/sec can be achieved. The modular design also minimizes programmatic risk because it will allow the use of materials at higher technology readiness levels and subsystems that do not have to be scaled up.

ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: As a source of high temperature, high-pressure hydrogen, the primary NASA application for this technology is ground test equipment for testing nuclear-thermal and solar-thermal propulsion systems. High-power NTP systems will benefit a variety of NASA missions that involve long transit times and/or the need to enter orbit at

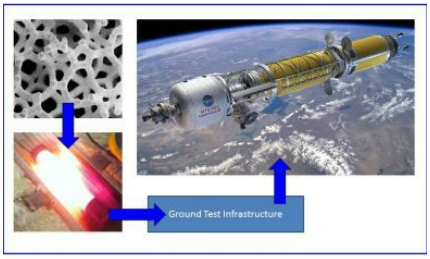

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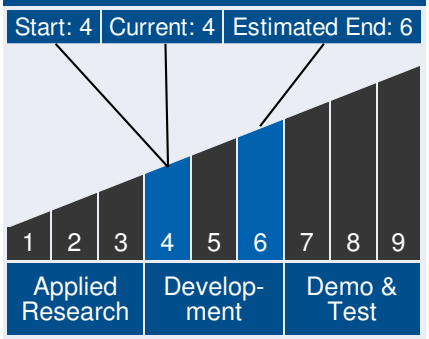
Table of Contents

Technology Maturity



Management Team

Program Executives:

- Joseph Grant
- Laguduva Kubendran

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the destination. High-power NTP systems will also benefit crewed missions beyond the Moon because they will result in shorter trip times, reducing the consumables load and reducing exposure to cosmic radiation. As a system for heating flowing propellants, the technology can be used as an igniter for monopropellant and non-hypergolic bipropellant engines. Such engines can be used for booster-class engines, reaction control engines on launch vehicles, and main and attitude control engines on satellites and interplanetary spacecraft. As a system for heating gases and liquids in general, the technology can be used in hypersonic wind tunnels.

To the commercial space industry:

Potential Non-NASA Commercial Applications: Military applications mirror many of the NASA applications, especially in terms of igniters for engines on launch vehicles and satellite propulsion systems. Hypersonic wind tunnels will also benefit from the technology. Perhaps the largest commercial applications would be ignition systems and catalyst heaters for turbine engines used for terrestrial power generation. Other applications include gas and water heaters where high efficiency is critical.

Management Team *(cont.)*

Program Manager:
- Carlos Torrez

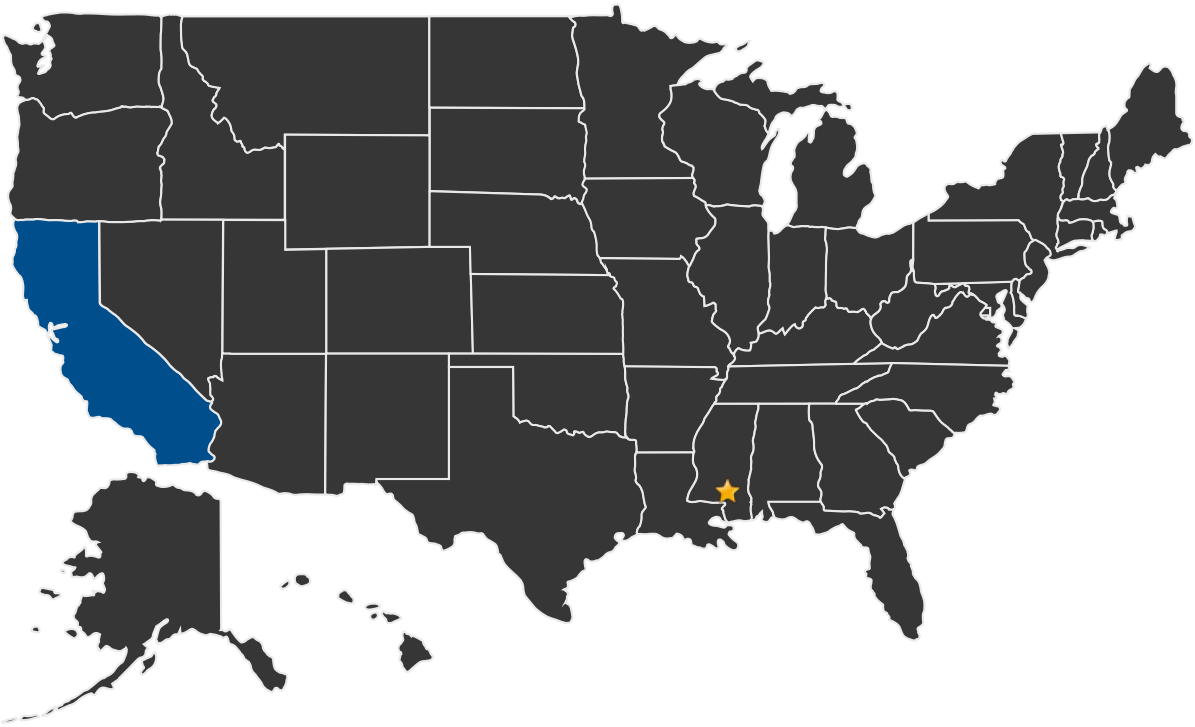
Principal Investigator:
- Arthur Fortini

Technology Areas

Primary Technology Area:
In-Space Propulsion Technologies (TA 2)
└ Non-Chemical Propulsion (TA 2.2)
  └ Thermal Propulsion (TA 2.2.3)
    └ Nuclear Thermal Propulsion (NTP) (TA 2.2.3.2)

Secondary Technology Area:
Materials, Structures, Mechanical Systems and Manufacturing (TA 12)
└ Structures (TA 12.2)
  └ Loads and Environments (TA 12.2.6)

U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Stennis Space Center

Other Organizations Performing Work:

- Ultramet (Pacoima, CA)

PROJECT LIBRARY

Presentations

- Briefing Chart
  - (http://techport.nasa.gov:80/file/17881)

DETAILS FOR TECHNOLOGY 1

Technology Title

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